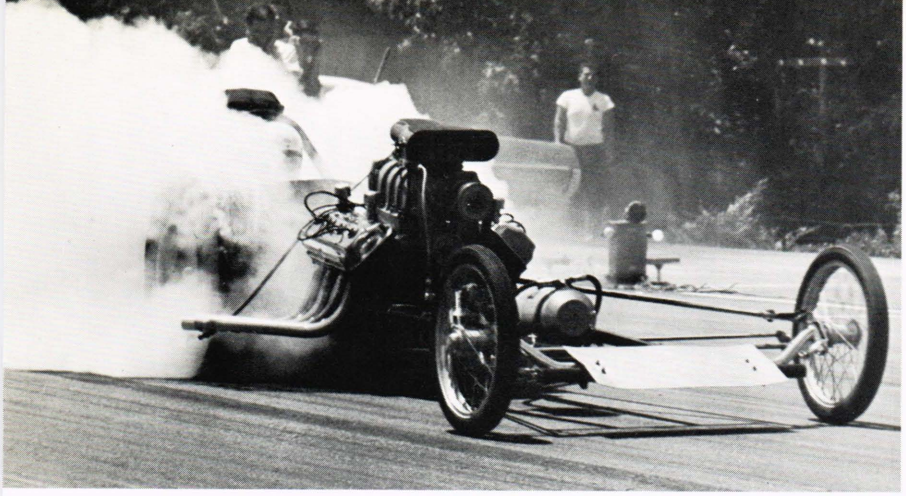

In this superb action shot of a fast getaway, the driver appears to be enveloped in smoke from the spinning rear tires. A set of starting-timing lights is seen in the background. (Photo by Nick Bilowick.)

"The Reese Bros." dragster

W. P. Reese

To begin an engineering-oriented discussion of drag racing is easy; the sport is simply a highly specialized application of Newton's second law.* Professional drag racing has as its object the desire to cover a given relatively short distance from a standing start in the shortest possible time. The only rules are simple: the vehicle must be automotive in nature, with an internal combustion engine driving through the wheels. There are no other requirements to be met, other than providing for the safety of the driver. The enjoyment and challenge of following these rules is my hobby,† and has resulted in a machine so unique in function and appearance as to merit careful description.

The sport of organized drag racing originated in southern California about 1951 as an attempt to eliminate the street racing of the teen-age group. Since then it has grown rapidly to the point where approximately 15 million paying spectators attended drag races in 1963. The heart of the sport is still located in southern California, but it is a truly nationwide activity, with about 200 active drag strips in the United States. All of them are similar, being straight flat stretches of asphalt, 60 to 100 feet wide, and 3000 to 5000 feet long. The first quarter mile, or 1320 feet, is the actual race portion, and the remainder is stopping room. All drag races are also similar, consisting of only two cars, aligned side by side at the starting line, starting at the wave of a flag or flash of a light, and accelerating to the finish line. The winner is the first car to the 1320-foot line, with the loser being eliminated (elapsed time, not top speed, is thus the critical factor in race results). In this manner a large group of competing cars may be rapidly reduced until the winner is determined. There are no second places in drag racing.

This is the sport to which my brother "Bub" and I have been ad-

Sitting in the driver compartment of the Chrysler dragster is "Bub" Reese, with his brother Phil standing by. Note that the driver is wearing neither aluminized protective clothing nor a body harness in this posed photo. Clearly seen is the necessarily excessive width of the rear tires, location of the driver compartment aft of the rear axle, the protective roll bar, and the drag parachute. (Photo by John A. Durand.)

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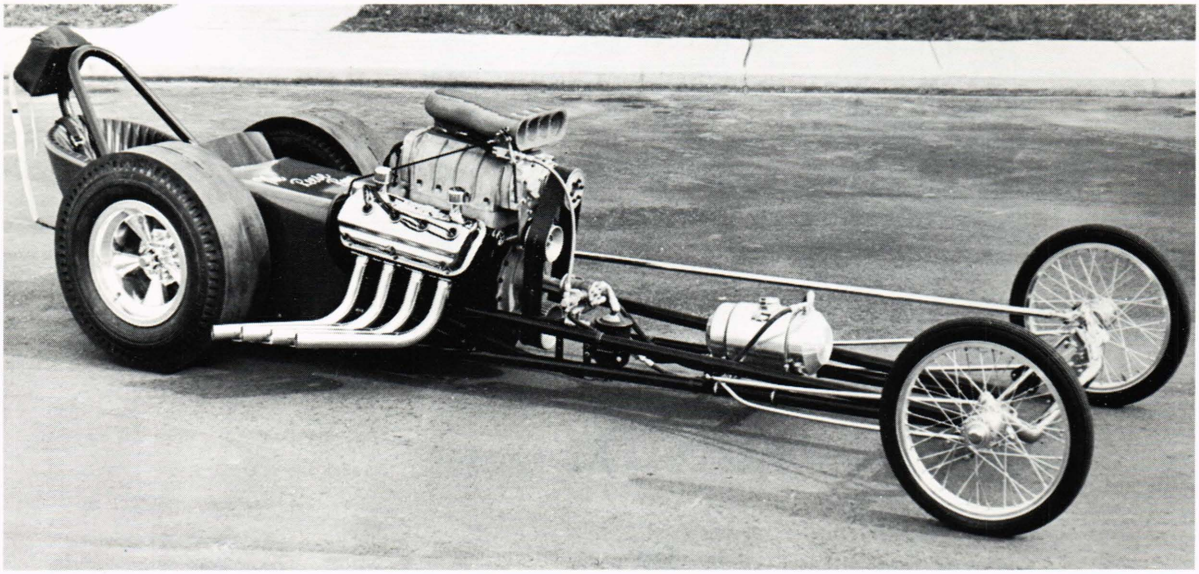
* The acceleration produced by a force is directly proportional to the force and inversely proportional to the mass of the body being accelerated.

† W. P. (Phil) Reese is an associate engineer in the Weapon System Performance Project of the Fleet Systems Analysis Group. His brother, H. Price (Bub) Reese is a data technician in the Semi-Automatic Equipment Project of the Bumblebee Instrumentation Development Group.



A recent photo of the Reese Bros. dragster. The General Motors supercharger atop the '57 Chrysler engine, fuel tank mounted between the two pairs of side rails, and high-speed Pirelli tires are clearly seen. (Photo by John A. Durand.)

dicted for quite a few years. We both got into it through the usual (for this sport) route—acquiring an old car as soon as we reached licensing age, fixing it up, and driving off to a drag strip to see how fast it would go. From that point we progressed through the modified-engine stage, and eventually, in 1959, reached the end of the line with a dragster.

A Handmade Vehicle

The car we have evolved in five years of development toward maximum straight-line acceleration is a supercharged, Chrysler-powered, tubular chassis known as a dragster. It is a completely handmade vehicle that costs several thousand dollars initially for parts alone.

Examination of the accompanying pictures will show that the engine is located aft of the center of the wheelbase, and that the driver sits behind the rear wheels. The reasoning for such a set-up is twofold. First, with more than 1200 horsepower available in a car weighing less than 1500 pounds, transmitting power to the ground becomes a serious problem and makes it necessary to place at least 75% of the car's total weight on the driving wheels. Second, because of the car's tendency to "fishtail" and drift under the extreme wheelspin and acceleration conditions, the "seat-of-the-pants" feeling is necessary for rapid corrective steering; this feeling is amplified by the driver's extreme rear location. To put the acceleration capabilities of our car in proper perspective, consider that it will accelerate from a standing start to 100 miles per hour in 2.2 to 2.4 seconds in 150 to 195 feet, and from 0 to about 195 or 200 mph in 7.5 to 8.3 seconds in ¼ mile. These times and speeds are not subject to question; timing at a drag strip is done by the car itself as it breaks light beams to photoelectric cells that start and stop the counting of pulses from a stable oscillator. Therefore, by knowing the time between breaking of successive beams, both elapsed times and average speeds can be determined.

The engine we are currently using for power is based on a 1957 Chrysler V-8, although the only Chrysler parts retained are the block and head castings and the crankshaft. For five years we also used a small-block Chevrolet V-8. An interesting side note here is that only the '57–'58 Chrysler firepower and the '55–'64 Chevrolet V-8 engines can be made competitive in drag racing, which says something about the efficiency of the design of other engines. In fact, we believe that the '57–'58 Chrysler, hemispherical-combustion-chamber, V-8 engine can be made to produce more total power than any other automotive engine ever built, including special engines designed and built exclusively for racers. As much as 1500 horsepower can be produced for short periods by a properly modified version of this engine. As far as this sport is concerned, I consider most other engines to be out of the running.

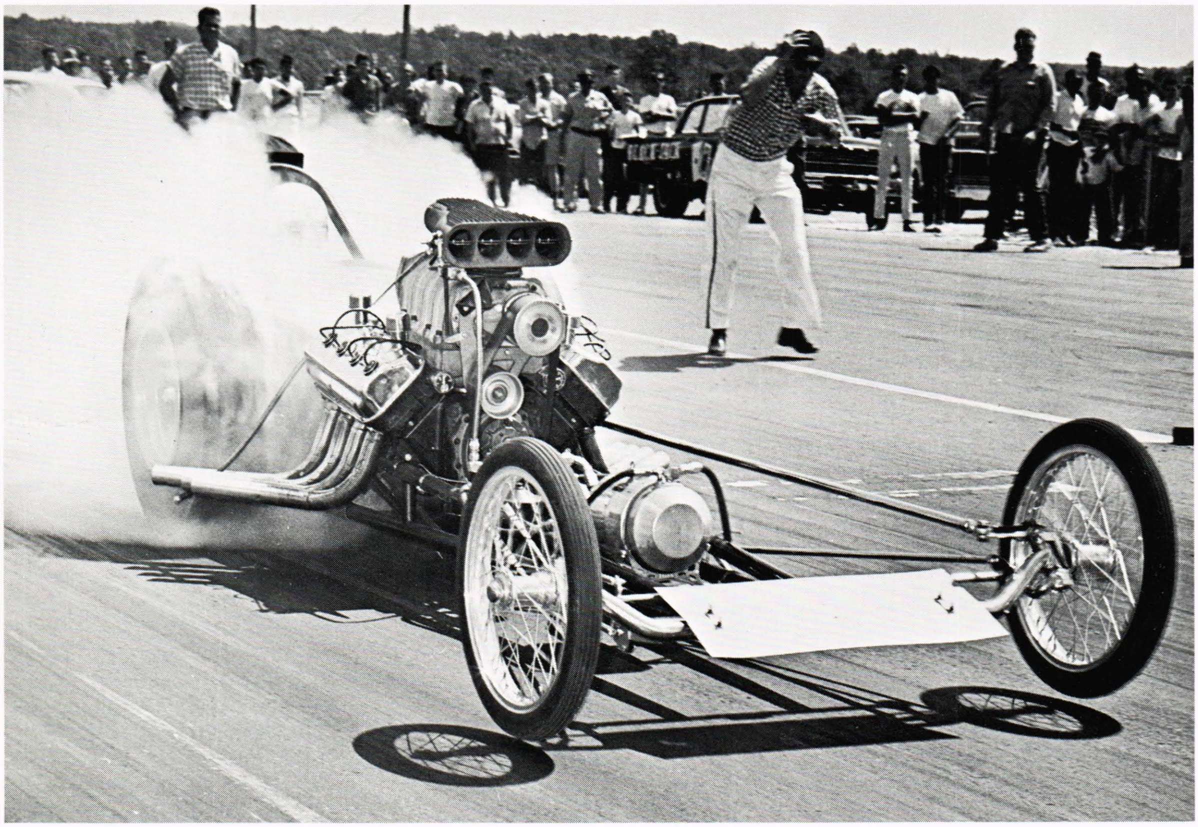
Precision and Strength of Construction

The following are details concerning the construction of our Chrysler-powered dragster. Starting at the bottom, the crankshaft is a standard-stroke, '57 Chrysler, 5-main-bearing forged-steel shaft, with the bearing journals industrial hard-chromed and ground to provide approximately three times the stock clearances. The shaft has been statically and dynamically balanced compatibly with the reciprocating parts to a tolerance of ½ gram-inch.

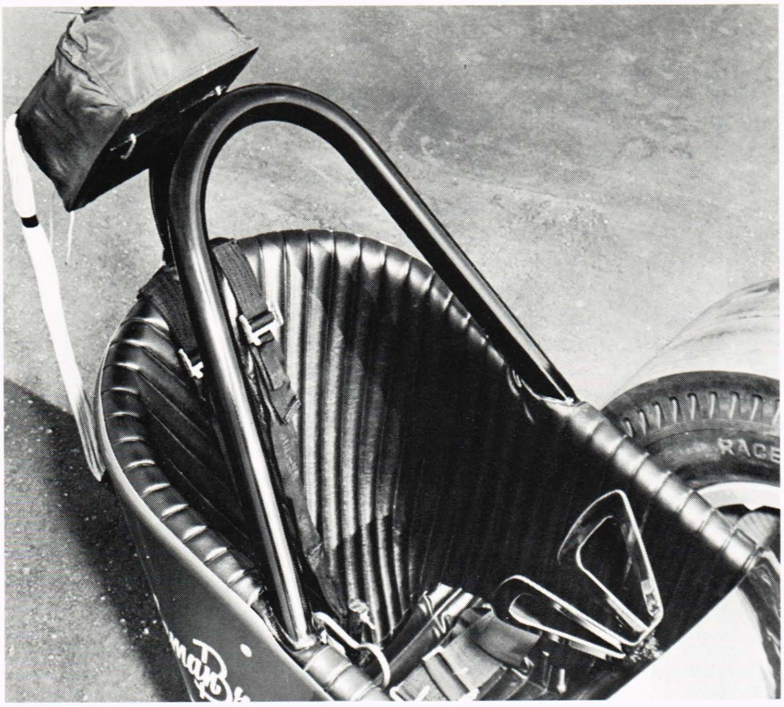
Before work on the crank or any of the moving parts was begun, all pieces made of ferrous materials were magnafluxed for cracks, or they were zygloed if of aluminum. With the tremendous forces of combustion produced, it is not uncommon for the crankshaft to be pushed out of the bottom of the block, tearing out the main bearings and all their associated webbing at the same time. To prevent this possibility, we have reinforced the entire bottom of the block with a cast-steel girdle that is bolted to the oil pan rails, with cross pieces rigidly supporting the three center main bearing caps. The tight compression fit of this "bottom-end" support badly distorted the main bearing saddles, so the block was align-bored with the support torqued in place to provide a straight and round path in which the crankshaft would turn. The connecting rods take advantage of the high strength-to-weight ratio of aluminum, and are high-density, forged-aluminum I-beams having about 10 times the cross-sectional area of a stock rod. These rods were balanced end-for-end as well as for total weight, and the wrist pins were precision fitted to 0.0005 inch ± 0.0001 inch clearance.

The pistons are also forged aluminum, flat-top, with notches to prevent valve-to-piston interference, and provide a mechanical compression ratio of 8 to 1 and a displacement of 398 cubic inches. Piston skirt-to-wall clearance cold is 0.040 inch. The head surface of the block was ground flat for good gasket sealing, and then a groove was machined around each cylinder for the insertion of 16-gauge copper wire that serves as an O-ring, aiding in the prevention of blown head gaskets.

The cylinder head intake and exhaust ports have been enlarged by grinding to the maximum size possible without falling through to the water jackets. The ports were then polished to a mirror-smooth finish. In a further attempt to improve the air-fuel flow, the valves were replaced with 2.125-inch stainless steel ones seated to a concentricity of ± 0.0001 inch. The block surface of the heads was also ground flat for good gasket seating after the volume of the combustion chambers had been equalized to within ½ cc. Valve springs necessary to force the valves and valve train to follow the rather radical camshaft provide 220 pounds of force with the valve on its seat, and more than 500 pounds with the valve fully opened. To prevent breakage under the severe cyclic loading, the rocker arms were replaced with forged steel items, magnafluxed for flaws, and then completely polished to foil stress concentrations. The spring retainers were replaced with aluminum ones, in the only attempt to reduce valve-train weight. Valve lash is set statically, hot, through the use of special adjustable push rods. The cam is a high-lift, long-duration, flat-tappet grind, whose lift, rate of lift, and duration fall into the realm of hot rodder's classified information, but it may be said that the valves are open approximately one complete engine revolution. Even the head bolts



A few feet from the starting line, tire smoke all but obscuring the driver, front wheels just off the ground, the Reese Bros. dragster is already traveling in excess of 50 mph. (Photo by John A. Durand.)



This photo of the driver compartment of the Chrysler-powered dragster shows clearly the steering "wheel," body harness, and parachute. The parachute-releasing "D" ring is seen at the driver's right. (Photo by John A. Durand.)

are magnafluxed and are torqued to 100 lb-ft to try to prevent head gasket blowing.

Note that up to this point only the enlarged ports and valves and the camshaft are items to increase power output, while all the other modifications are to improve reliability.

Since a drag race requires that the engine produce power for only about 8 seconds, and the line-up to start needs at most 45 seconds of engine idling, no engine cooling system is necessary. This being the case, the entire cylinder-block water jackets are solidly filled with a substance resembling a cross between plaster of Paris and cement. This material adds rigidity to the cylinder walls, which, if not reinforced, tend to split under the high combustion pressures. The cylinder heads contain water, which is changed after each race to cool the combustion chambers.

On top of the engine, on the special intake manifold, sits one-half of the real power team—a positive-displacement Roots-type supercharger. Our engine is known in the sport as being "mit kompressor." These superchargers are of the two-rotor, three-vane type, and are original equipment on General Motors Corp. 6-71 diesel engines. To say that the blower is extensively modified is an understatement. To allow operation at two to three times their design speed, they are clearanced, the rotors balanced and pinned to the shafts, special gears are installed, heavier end bearings are put in, and a special drive system is constructed. The blower is driven by a geared Gilmer belt 3 inches wide, at from 10 to 30% above engine speed. At 7000 rpm, the supercharger requires about 150 horsepower to turn, but its net contribution to the engine output is several times that figure. At 5000 engine rpm the positive pressure in the intake manifold is about 22 psi above atmospheric, which results in an effective compression ratio of about 20 to 1. The manifold is fitted with spring-loaded pop-off valves to prevent damage from backfires.

Atop the supercharger is the fuel injection unit that supplies the other half of the power team—the nitro fuel. The fuel injection unit is simply a constant-flow device, with a pump driven at one-half engine speed off the front of the cam, and with the fuel flow being metered in relation to the throttle opening.

The fuel is a blend of nitromethane, methyl alcohol, propylene oxide, and benzol. The exact percentages are competition secrets, although the nitro and the alcohol make up over 90% of the total. Since the fuel bears its own oxygen and is not dependent on outside air to achieve any particular fuel-air ratio but only to atomize the liquid nitro, great quantities of nitro can be consumed. The car will use about one gallon in 8 seconds.

Ignition is supplied by a Swiss-made Scintilla magneto, fitted with a special base adapting it to the Chrysler's original distributor drive. Spark plugs survive only one 8-second race and are then discarded. No particular brand has been found superior, or for that matter, even completely satisfactory.

Power and Control

Power is transmitted via a double-disc, semi-centrifugal clutch with all bronze mating surfaces from an Oldsmobile differential with a 3.23 ratio. The differential is not locked, and it is absurd to think of a ratio-increasing transmission in the drive line because the engine will easily spin the tires at the driver's will, even in direct drive. In fact, transferring the power to the ground is a real problem, and is not yet completely solved.

In the present state of the art, it is no problem to develop more power than can possibly be transmitted to the ground at the start of a race. The tires we use are 10.5 inches wide, with a flat road surface, and devoid of tread. Tread patterns are necessary on ordinary tires only to provide a place for water to go when squeegeed out from under the tire on a wet road. Since racing our car on even a damp track is unthinkable, who needs tread? The tires are the widest made, and they represent a compromise between maximum traction at starting and stability at 200 mph. They are new, of 6-ply nylon construction, register between 50 and 54 on a durometer, and last about 10 races before they are completely worn out. These tires provide a contact with the road that is somewhere between pure friction and a geared contact. This allows an *apparent* coefficient of friction in excess of 1, allowing starting accelerations of approximately 2 g's. The wheels are 10.25-inch-wide, 16-inch-diameter magnesium castings.

The chassis required to contain the power output of the engine and channel it to a straight line down the strip also represents considerable thought. The basic frame is of 1.75-inch-diameter, 0.065-inch-wall mild steel tubing (chosen for its ease of welding). It is basically two "rails" on each side, tapering in the front to meet the front cross member, and expanding in the back to include the driver's protective roll cage. All tubes in the roll cage are of ⅛-inch-wall thickness. The rear housing is bolted securely to the frame since there is no suspension system that can handle the torque output and still function as a flexible support of the car's light weight. Besides, a decent drag strip is fairly smooth.

The front axle is suspended by adjustable torsion bars, and each front wheel can be loaded independently, causing unequal loading of the rear wheels. Careful selection and setting of the cross-chassis weight distribution leads to a car that goes straight under power. The front wheels are medium-weight motorcycle wheels with special high-speed Pirelli tires. Steering is ultra-quick, utilizing a worm and sector box from a Crosley of unknown vintage, and a folded-butterfly wheel.

The brakes, on the rear wheels only, are the best available—dual-spot disc aircraft type, which are capable of locking the rear wheels at any time at the touch of the handle (the car has only a hand-operated brake), and are absolutely impervious to fade. Stopping is assisted by a custom-designed parachute, which is released at the finish line and which will provide 3 to 4 g's deceleration at 180 mph. The chute is designed for deployment at speeds considerably higher than those that are usual for "cargo chutes," and it is stable, i. e., does not oscillate, at high speeds.

The overall front-to-rear weight distribution is set at the maximum possible on the rear wheels in such a way that the inertia-driving-force couple does not lift the front wheels from the track at the start. The wheels-in-the-air attitude occasionally assumed by these cars at the start is not only undesirable from the standpoint that the driver cannot see where he is going or make steering corrections, but that it is usually disastrous to the machinery when it comes down.

The Safety Factor

The driver's protective equipment, in addition to the roll cage, consists of a complete aluminum fire-proof suit, gloves, and mask, and a high-quality crash helmet. He is securely held within the confines of the cage by a shoulder harness and seat belt. The driver's compartment is tight-fitting and contains a folded-butterfly steering wheel that is sufficient since a maximum of only one-half turn is ever needed during a race. Other equipment in this compartment includes a combination fuel-shut-off and parachute release that is pulled at the finish line, a hand-operated brake, and the conventionally located accelerator and clutch pedals. Ignition control is handled by a magneto grounding toggle switch, but the engine is turned off by the fuel shut-off.

The two action pictures show heavy tire smoke, which is the usual starting mode and which continues throughout a race. In these shots the car is accelerating at about 2 g's, is going about 50 mph, has been underway about one second, and is roughly one car length past the starting line. Nothing but clear, colorless, burned gases are coming out of the exhaust pipes.

Maintenance and Men

The maintenance, both preventative and corrective, that is normally associated with a vehicle like this seems to astound the public. Each week the heads are pulled and a valve job done, the head gaskets and O-rings replaced, and the cylinder walls inspected both for cracks and to determine the correctness of the previous week's state of tune. The fuel injection is disassembled and inspected for clogs and leaks, and the supercharger is examined for cracks. The pan is dropped and the bearings inspected, although replacement has not been necessary to date. All bolts and fittings on the car are tightened following each race, and the valves are adjusted. The timing is checked exactly after each run also. The head gaskets, when they blow, are sometimes replaced in the 45-minute period between races. It is of interest to add that immediately following any partial or complete disassembly and assembly the car must be ready and able to go out on the track and race full bore.

The competitive driving of our car is handled entirely by Bub. The sensation of driving our dragster could be gotten in an ordinary car by accelerating to about 100 mph on a narrow road partly covered by ice and with a few bare patches, suddenly turning the steering wheel one-quarter turn at full throttle, and then taking it from there with the hope of aiming the car between two telephone poles 20 feet apart.

Although we hold no national titles, primarily because most title races are held in southern California, our car is one of the two or three fastest on the east coast. Our biggest wins to date with the present car have been the season-opener fuel meet at York, Pa., last April, and the *Dragsters Unlimited* fuel meet at Hagerstown, Md., in July.

In addition to our actual racing activities, plus the hundreds of hours we spend in the shop to keep the dragster in top form, I am an associate editor of *Eastern Drag News,* a weekly drag-racing newspaper devoted to race results and technical commentary that is distributed from Massachusetts to North Carolina. I am also an editor of the *Annual Pictorial of Eastern Drag Racing,* a widely circulated magazine containing hundreds of still and action photos of eastern racers as well as general-interest photos about the eastern scene.